

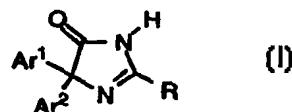
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(71) Applicant: BRISTOL-MYERS SQUIBB COMPANY [-/US]; 5 Research Parkway, Wallingford, CT 06492 (US).		
(72) Inventors: POINDEXTER, Graham, S.; 15 Fox Hollow Road, Old Saybrook, CT 06475 (US). GILLMAN, Kevin; 80 Bradley Corners Road, Madison, CT 06443 (US).		
(74) Agent: RYAN, Richard, P.; Bristol-Myers Squibb Company, 5 Research Parkway, Wallingford, CT 06492 (US).		

(54) Title: IMIDAZOLONE ANORECTIC AGENTS: I. ACYCLIC DERIVATIVES**(57) Abstract**

A series of non-peptidergic antagonists of NPY have been synthesized and are comprised of acyclic derivatives of imidazolone compounds of Formula (I). As antagonists of NPY-induced feeding behavior, these compounds and known analogs are expected to act as effective anorexiant agents in promoting weight loss and treating eating disorders.



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IMIDAZOLONE ANORECTIC AGENTS:

I. ACYCLIC DERIVATIVES

Cross Reference to Related Application

This continuation-in-part application claims priority from provisional
5 application USSN 60/079,359 filed March 25, 1998.

Background of the Invention

The present invention concerns heterocyclic carbon compounds comprising 2-substituted acyclic derivatives of 5,5-diphenyl-3,5-dihydroimidazolones which have been discovered to be NPY antagonists.

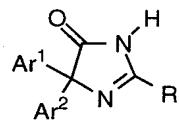
10 2,5,5 (or 2,4,4) -triphenyl-2-imidazolin-4 (or 5)- ones, including
analogs wherein the phenyl rings bear an alkyl, alkoxy, or halo substituent,
have been described in the chemical literature, generally in connection with
chemical process and organic chemical reaction mechanism studies. So
too have 5,5-diphenyl-2-imidazolin-4-ones, bearing a C₁₋₄ alkyl substituent
15 in the 2-position, been described.

Antagonism of neuropeptide Y receptors has been postulated to reduce food consumption in mammals. Several non-peptidic chemotypes have been disclosed in the literature as being antagonists at the Y₁ and at the Y₅ subtypes of NPY receptors. (See Gehlert and Hipskind, Exp. Opin. Invest. Drugs, 1997, 6, pp. 1827-1838.)

Neither applicants' novel 2-substituted acyclic derivatives of 5,5-diphenyl-dihydroimidazolones nor the use of these and related dihydroimidazolones for use in treating medical disorders by means of antagonizing NPY receptors following administration of these compounds is
25 known or suggested by prior art.

Summary and Detailed Description of the Invention

The present invention comprises compounds of Formula I, their



(I)

5 pharmaceutically acceptable acid addition salts and/or their hydrates thereof. In the foregoing structural Formula I, the symbols R, Ar¹ and Ar² have the following meanings.

10 R is selected from C₂₋₆ alkenyl, C₁₋₆ alkoxy, and C₁₋₆ alkyl substituted with R¹. R¹ is C₁₋₄ alkoxy, C₃₋₈ cycloalkyl, trifluoromethyl, trichloromethyl, and phenoxy and phenylthio, either unsubstituted or phenyl-ring substituted with a trifluoromethyl group.

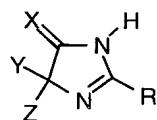
Ar¹ and Ar² are independently selected from  with R²

being hydrogen, C₁₋₄ alkyl or alkoxy, and halogen.

15 Preferred compounds are Formula I compounds wherein R is C₁₋₆ alkyl, substituted with R¹, with trichloromethyl and phenylthio being preferred for R¹. R² preferably is hydrogen.

20 Another aspect of the invention is the use of structurally related imidazolones to treat medical disorders involved with NPY receptor binding. In this regard, compounds of Formula II are to be administered for treatment of conditions and disorders in which binding at NPY receptors is implicated.

Formula II compounds have the following structural features.

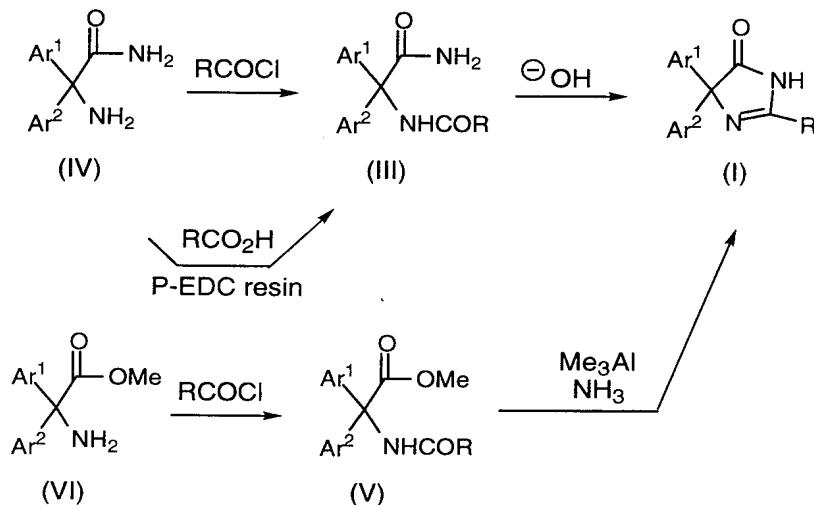


(II)

Y and Z are independently selected from phenyl, optimally substituted phenyl, indole, optimally substituted indole, thienyl, and furanyl. X is oxygen or sulfur. R is selected from C₁₋₆ alkanyl, C₂₋₆ alkenyl, C₁₋₆ alkoxy, C₁₋₆ alkyl, substituted with R¹. R¹ is C₁₋₄ alkoxy, C₃₋₈ cycloalkyl, trifluoromethyl, trichloromethyl, phenoxy and phenylthio, either unsubstituted on the phenyl ring or substituted with a trifluoromethyl group. As can be seen, Formula II is broader than and encompasses Formula I.

As indicated, the present invention also pertains to pharmaceutically acceptable salts of the Formula I and II compounds. Such salts include those derived from organic and inorganic acids such as, without limitation, hydrochloric, hydrobromic, phosphoric, sulfuric, methanesulfonic, acetic, fumaric, tartaric, moleic, succinic, lactic, citric acid, and the like.

Formula I compounds can be produced by using the processes shown in Scheme 1. The symbols Ar¹, Ar² and R are as previously defined.

Scheme 1

Unless otherwise indicated in the Specific Embodiments section, known intermediates IV and VI were prepared by standard literature methods. (A typical synthesis of Formula IV compounds is described by Edward, *et al.*, *Can. J. Chem.*, 1967, 45, p. 1925. A typical Formula VI compound synthesis is described by Skelly, *et al.*, *J. Org. Chem.*, 1985, 50, p. 267.)

Similar processes employing appropriate modifications can be utilized to provide compounds of Formula II. In addition, synthesis of certain Formula II compounds can be found in the chemical literature. Various reaction intermediates and Formula II products can be prepared by modifications known to one skilled in the art. Additional examples and procedures are provided *infra*.

The compounds of Formulas I and II demonstrate binding affinity at NPY receptors. The binding interaction has been characterized as antagonism at NPY Y_5 receptors. This pharmacologic activity was characterized by using BRI-TN-5BI-4 insect cells infected with NPY Y_5 -recombinant Baculovirus. These cells which express Y_5 receptor were used in a radioligand binding assay employing Iodine-125 labeled PYY ligand. The imidazolones of this invention all showed IC_{50} values of less than 1 μM .

Formula I and II compounds had good binding affinities as evidenced by IC_{50} values being about 10 μ M or less at NPY Y_5 receptors. Preferred compounds have IC_{50} values less than 200 nM.

Pharmacologically, these compounds act as selective NPY antagonists at NPY Y_5 receptor sites. As such, the compounds of Formulas I and II are of value in the treatment of a wide variety of clinical conditions which are characterized by the presence of an excess of neuropeptide Y. Thus, the invention provides methods for the treatment or prevention of a physiological disorder associated with an excess of neuropeptide Y, which 10 method comprises administering to a mammal in need of said treatment an effective amount of a compound of Formula I or II or a pharmaceutically acceptable salt, solvate or prodrug thereof. The term "physiological disorder associated with an excess of neuropeptide Y" encompasses those disorders associated with an inappropriate stimulation of neuropeptide Y receptors, 15 regardless of the actual amount of neuropeptide Y present in the locale.

These physiological disorders include:

- disorders or diseases pertaining to the heart, blood vessels or the renal system, such as vasospasm, heart failure, shock, cardiac hypertrophy, increased blood pressure, angina, myocardial infarction, sudden cardiac 20 death, congestive heart failure, arrhythmia, peripheral vascular disease, and abnormal renal conditions such as impaired flow of fluid, abnormal mass transport, or renal failure;
- conditions related to increased sympathetic nerve activity for example, during or after coronary artery surgery, and operations and 25 surgery in the gastrointestinal tract;
- cerebral diseases and diseases related to the central nervous system, such as cerebral infarction, neurodegeneration, epilepsy, stroke, and conditions related to stroke, cerebral vasospasm and hemorrhage, depression, anxiety, schizophrenia, dementia, seizure, and epilepsy;
- 30 • conditions related to pain or nociception;

- diseases related to abnormal gastrointestinal motility and secretion, such as different forms of ileus, urinary incontinence, and Crohn's disease;
- abnormal drink and food intake disorders, such as obesity, anorexia, bulimia, and metabolic disorders;

5 • diseases related to sexual dysfunction and reproductive disorders;

- conditions or disorders associated with inflammation;
- respiratory diseases, such as asthma and conditions related to asthma and bronchoconstriction;
- diseases related to abnormal hormone release, such as leutinizing 10 hormone, growth hormone, insulin and prolactin;
- sleep disturbance and diabetes.

There is evidence that NPY contributes to certain symptoms in these disorders: hypertension, eating disorders, and depression/anxiety; as well 15 as circadian rhythms. Compounds of this invention are expected to be useful in treating these disorders as well as sleep disturbance and diabetes.

Selected compounds are tested further for their ability to block or stimulate NPY-induced feeding in test animals by intraperitoneal administration to the animal prior to inducing feeding behavior with NPY. Taken together, these tests indicate that the compounds of this invention 20 would be useful anorexiants and would function as anti-obesity agents with further use in various clinical eating disorders. Thus, another aspect of the invention concerns a process for reducing food intake in an obese mammal or a mammal with an eating disorder. The process comprises systemic administration to such a mammal of an anorexiант-effective dose of a 25 compound of Formula I or II or a pharmaceutically acceptable acid addition salt and/or hydrate thereof.

On the basis of pharmacologic testing, an effective dose given parenterally could be expected to be in a range of about 0.05 to 1 mg/kg

body weight and if given orally would be expected to be in the range of about 1 to 20 mg/kg body weight.

For clinical applications, however, the dosage and dosage regimen must in each case be carefully adjusted, utilizing sound professional judgment and considering the age, weight and condition of the recipient, the route of administration and the nature and gravity of the illness. Generally, the compounds of the instant invention will be administered in the same manner as for available anorexiant drugs such as Diethylpropion, Mazindol, or Phentermine and the daily oral dose would comprise from about 70 to 10 about 1400 mg, preferably 500 to 1000 mg administered from 1 to 3 times a day. In some instances, a sufficient therapeutic effect can be obtained at lower doses while in others, larger doses will be required.

The term systemic administration as used herein refers to oral, buccal, transdermal, rectal, and parenteral (i.e. intramuscular, intravenous, and subcutaneous) routes. Generally, it will be found that when a compound of the present invention is administered orally, which is the preferred route, a larger quantity of reactive agent is required to produce the same effect as a smaller quantity given parenterally. In accordance with good clinical practice, it is preferred to administer the instant compounds at a concentration level that will produce effective anorectic effects without causing any harmful or untoward side effects. Similarly, the instant compounds can be administered to treat the various diseases, conditions, and disorders listed supra.

Therapeutically, the instant compounds are generally given as pharmaceutical compositions comprised of an effective anorectic amount of a compound of Formula I or II or a pharmaceutically acceptable acid addition salt thereof and a pharmaceutically acceptable carrier. Pharmaceutical compositions for effecting such treatment will contain a major or minor amount, e.g. from 95 to 0.5% of at least one compound of the present invention in combination with the pharmaceutical carrier, the carrier comprising one or more solid, semi-solid, or liquid diluent, filler, and formulation adjuvant which is non-toxic, inert and pharmaceutically acceptable. Such pharmaceutical compositions are preferably in dosage unit forms; i.e., physically discrete units containing a predetermined amount of the drug corresponding to a fraction or multiple of the dose which is

calculated to produce the desired therapeutic response. The dosage units can contain 1, 2, 3, 4, or more single doses, or, alternatively, one-half, one-third, or one-fourth of a single dose. A single dose preferably contains an amount sufficient to produce the desired therapeutic effect upon

5 administration at one application of one or more dosage units according to the pre-determined dosage regimen usually a whole, half, third, or quarter of the daily dosage administered once, twice, three, or four times a day. Other therapeutic agents can also be present. Pharmaceutical compositions which provide from about 50 to 1000 mg of the active ingredient per unit

10 dose are preferred and are conventionally prepared as tablets, lozenges, capsules, powders, transdermal patches, aqueous or oily suspensions, syrups, elixirs, and aqueous solutions. Preferred oral compositions are in the form of tablets or capsules and may contain conventional excipients such as binding agents (e.g. syrup, acacia, gelatin, sorbitol, tragacanth, or

15 polyvinylpyrrolidone), fillers (e.g. lactose, sugar, maize-starch, calcium phosphate, sorbitol, or glycine), lubricants (e.g. magnesium stearate, talc, polyethylene glycol or silica), disintegrants (e.g. starch) and wetting agents (e.g. sodium lauryl sulfate). Solutions or suspensions of a Formula I compound with conventional pharmaceutical vehicles are generally

20 employed for parenteral compositions such as an aqueous solution for intravenous injection or an oily suspension for intramuscular injection. Such compositions having the desired clarity, stability and adaptability for parenteral use are obtained by dissolving from 0.1% to 10% by weight of the active compound in water or a vehicle consisting of a polyhydric aliphatic

25 alcohol such as glycerine, propyleneglycol, and polyetheleneglycols or mixtures thereof. The polyetheleneglycols consist of a mixture of non-volatile, usually liquid, polyetheleneglycols which are soluble in both water and organic liquids and which have molecular weights from about 200 to 1500.

30

Description of the Specific Embodiments

The compounds which constitute this invention and their methods of preparation will appear more fully from a consideration of the following examples which are given for the purpose of illustration only and are not to be construed as limiting the invention in sphere or scope. All temperatures 35 are understood to be in degrees C when not specified.

The nuclear magnetic resonance (NMR) spectral characteristics refer to chemical shifts (δ) expressed in parts per million (ppm) versus tetramethylsilane (TMS) as reference standard. The relative area reported for the various shifts in the proton NMR spectral data corresponds to the 5 number of hydrogen atoms of a particular functional type in the molecule. The nature of the shifts as to multiplicity is reported as broad singlet (br s), singlet (s), multiplet (m), doublet (d), triplet (t) doublet of doublets (dd), quartet (q) or pentuplet (p). Abbreviations employed are DMSO-d₆, (deuterodimethylsulfoxide), CDCl₃ (deuterochloroform), and are otherwise 10 conventional. The infrared (IR) spectral descriptions include only absorption wave numbers (cm⁻¹) having functional group identification value. The IR determinations were generally employed using potassium bromide (KBr) as diluent. The elemental analyses are reported as percent by weight. Melting points were obtained using a Thomas Hoover capillary apparatus and are 15 uncorrected. Mass spectra (*m/z*; MH⁺) and analytic HPLC (retention time and peak area %) data were obtained.

Example 1: General acylation/cyclization procedure for the preparation of imidazolones

α -Amino- α,α -diarylacetamide (IV) (0.050g, 0.22 mmol) was added to 20 a solution of the corresponding carboxylic acid (0.44 mmol), and 0.690g of P-EDC resin (1.4meq/g, 0.88mmol) in 5 ml dry CH₂Cl₂. [P-EDC resin was synthesized as described by known literature procedures (e.g., Desai, *et al.*, *Tetrahedron Lett.*, 1993, 48, p. 7685) and is as follows: To a stirred solution of 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide (13.02g, 84mmole) in 50 25 mL anhydrous N,N-dimethylformamide (DMF) was added chloromethylated polystyrene-divinylbenzene 2% resin (50g, 70 meq. of Cl; 200-400 mesh, 1.4 meq. Cl/g). After stirring at 100 °C overnight, the mixture was cooled and filtered. The resin was washed (200 mL x 3) each with DMF, tetrahydrofuran (THF), and diethyl ether. The resin was then dried in vacuo 30 under reduced pressure providing 60.8g of P-EDC.]

The reaction mixture was shaken for 36 h at rt, then the crude reaction mixture was filtered and the filter cake was washed with excess CH₂Cl₂. The resulting filtrate was evaporated *in vacuo* to yield a crude solid. This solid was dissolved in 3 mL EtOH and 0.5 mL of 1N NaOH(aq.). The 35 resulting solution was stirred for 16 h then neutralized with 1N HCl(aq). The

solvent was evaporated *in vacuo* and the crude solid was purified by reverse phase HPLC chromatography (YMC Inc., 20 x 100mm, 5 μ m particle size, 120 \AA pore size, C18 stationary phase, ODS-A fast elution: 50-100% (10%MeOH/90%H₂O-0.1%TFA):(90%MeOH/10%H₂O-0.1%TFA) providing
5 pure imidazolones of Formulas I and II.

Using this procedure with reactants being α -amino- α,α -diphenylacetamide and α -cyclopentylacetic acid gave product in Example 2.

10 Example 2: 2-(Cyclopentylmethyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

This compound was isolated as an off white solid in 6% yield. LRMS *m/z* (ESI) 319.16 (M+H)⁺; HPLC ret time 6.83 min.

In similar fashion, additional examples can be produced by selection of the appropriate reactants.

15 Example 3: 2-(2-Methylpropyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

This compound was isolated as an off white solid in 1% yield. LRMS *m/z* (ESI) 293.13 (M+H)⁺; HPLC ret time 6.88 min.

Example 4: 2-(3-Butenyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

20 This compound was isolated as an off white solid in 5% yield. LRMS *m/z* (ESI) 291.11 (M+H)⁺; HPLC ret time 4.52 min.

Example 5: 2-(Ethoxymethyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

This compound was isolated as an off white solid in 20% yield. LRMS *m/z* (ESI) 295.12 (M+H)⁺; HPLC ret time 5.03 min.

Example 6: 2-(3-Methyl-1-butenyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

This compound was isolated as an off white solid in 5% yield. LRMS *m/z* (ESI) 305.22 (M+H)⁺; HPLC ret time 2.96 min.

5 Example 7: 2-(3-Trifluoromethyl-phenylthiomethyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

This compound was isolated as an off white solid in 27% yield. LRMS *m/z* (ESI) 427.20 (M+H)⁺; HPLC ret time 3.52 min.

10 Example 8: 2-(3,3,3-Trichloropropyl)-3,5-dihydro-5,5-diphenyl-4H-imidazol-4-one

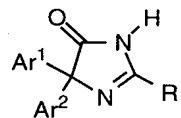
This compound was isolated as an off white solid in 47% yield. LRMS *m/z* (ESI) 381.14 (M+H)⁺; HPLC ret time 3.87 min.

Example 9: Receptor Binding Assay

Human cDNA of the NPY Y₅ receptor was PCR-corrected in
15 Baculovirus which was then used to infect "Hi5" (BTI-TN-5B1-4) insect cells during 48 hr incubation. The cells were harvested and used for the binding assay using iodine-125-labeled-PYY ([¹²⁵I]PYY) as a radioligand. Saturation binding used 0.05-100nM [¹²⁵I]PYY. Nonspecific binding was determined in the presence of 1000 nM unlabeled PYY and was less than
20 20% of total binding.

Claims

1. A compound of Formula I and its pharmaceutically acceptable

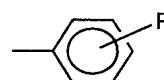


(I)

5 acid addition salts and/or hydrates thereof, wherein

R is selected from C₂₋₆ alkenyl, C₁₋₆ alkoxy, and C₁₋₆ alkyl substituted with R¹; wherein

10 R¹ is C₁₋₄ alkoxy, C₃₋₈ cycloalkyl, trifluoromethyl, trichloromethyl, and phenoxy and phenylthio, either unsubstituted or phenyl-ring substituted with a trifluoromethyl group; and

Ar¹ and Ar² are independently selected from  with R² being hydrogen, halogen, C₁₋₄ alkyl or alkoxy.

2. A compound of claim 1 wherein Ar¹ and Ar² are phenyl.

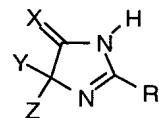
3. A compound of claim 2 wherein R is C₁₋₆ alkyl substituted with R¹.

15 4. A compound of claim 3 wherein R¹ is selected from trichloromethyl and phenylthio.

5. A method of promoting weight loss and treating eating disorders in a mammal comprising administration to a mammalian host of an effective anorexiant dose of a compound claimed in claim 1.

20 6. A method of promoting weight loss and treating eating disorders in a mammal comprising administration to a mammalian host of an effective

anorexiant dose of a compound of Formula II or a pharmaceutically acceptable salt and/or hydrate thereof,



(II)

5 wherein Y and Z are independently selected from furanyl, thieryl, indole, optimally substituted indole, phenyl and optimally substituted phenyl;

X is O or S; and

R is selected from C₁₋₆ alkanyl, alkenyl, alkoxy, and C₁₋₆ alkyl substituted with R¹; wherein

10 R¹ is C₁₋₄ alkoxy, C₃₋₈ cycloalkyl, trifluoromethyl, trichloromethyl, phenoxy and phenylthio, either unsubstituted or substituted with a trifluoromethyl group.

7. A pharmaceutical composition for use in promoting weight loss and treating eating disorders, the composition comprising an effective
15 anorexiant amount of a Formula I compound claimed in claim 1 in combination with a pharmaceutically acceptable carrier.

8. A pharmaceutical composition for use in promoting weight loss and treating eating disorders, the composition comprising an effective
20 anorexiant amount of a Formula II compound claimed in claim 6 in combination with a pharmaceutically acceptable carrier.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/04594

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :Please See Extra Sheet.

US CL :548/317.1, 325.5, 323.5; 514/398

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 548/317.1, 325.5, 323.5; 514/398

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Please See Extra Sheet.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2,744,852 A (GOODMAN) 08 May 1956, see entire document.	1-8
A	US 3,629,279 A (PESTERFIELD) 21 December 1971, see entire document.	1-8
A	US 3,894,008 A (IRVINE) 08 July 1975, see entire document.	1-8
A	US 4,304,782 A (DUMONT ET AL.) 08 December 1981, see entire document.	1-8
A	US 5,210,210 A (DAVIES) 11 May 1993, see entire document.	1-8
A	US 5,698,704 A (JACKSON) 16 December 1997, see entire document.	1-8

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search

21 APRIL 1999

Date of mailing of the international search report

14 MAY 1999

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Facsimile No. (703) 305-3230

Authorized officer
D. Lawrence Higel
FLOYD D. HIGEL aco

Telephone No. (703) 308-1235

INTERNATIONAL SEARCH REPORT

International application No. PCT/US99/04594

A. CLASSIFICATION OF SUBJECT MATTER:
IPC (6):

C07D 233/40, 233/42, 233/72, 233/74, 233/84, 233/86; A61K 31/415

B. FIELDS SEARCHED

Documentation other than minimum documentation that are included in the fields searched:

Chemical Abstract

Current Abstracts of Chemistry

Index Chemicus